YRKESHÖGSKOLAN NOVIA

Organizing Small Parts in Storage Container to Reduce Cost, Time and Wastage of Material for Power Plant Projects

Alexander Norrgård

Degree Thesis for Bachelor of Engineering

Degree Programme in Industrial Management and Engineering

Vasa 2020

BACHELOR'S THESIS

Author:	Alexander Norrgård
Degree Programme:	Industrial Management
Supervisor(s):	Peter Bergqvist och Joseph Koshy, Wärtsilä Niklas Kallenberg, Yrkeshögskolan Novia

Title: Organizing Small Parts in Storage Container to Reduce Cost, Time and Wastage of Material for Power Plant Projects

Date: May 24, 2020 Number of pages: 21 Appendices: 6

Abstract

This thesis is written for Wärtsilä Energy Business. The purpose of the thesis is to reduce the usage of fast air freight for material needed at power plant sites around the world and to make sure commissioning engineers know where the material is when needed by using a storage container.

I have gathered data from experts at Wärtsilä and subcontractors using meetings and interviews. The data consisted of material that often breaks at the power plant site and therefore are needed in short order.

The result of the thesis includes four sets of layouts for containers and an excel sheet with material as well as new relevant ideas that have occurred during my execution of the thesis. There has been a demand for decreasing the amount of fast air freight usage in power plant projects for some time, and this fulfills that purpose.

Language: English Key words: Container, data, logistics, cost reduction, freight

EXAMENSARBETE

Författare:	Alexander Norrgård
Utbildning och ort:	Produktionsekonomi, Vasa
Handledare:	Peter Bergqvist och Joseph Koshy, Wärtsilä
	Niklas Kallenberg, Yrkeshögskolan Novia

Titel: Organisera reservdelar i lagringskontainer för att minska kostnad, tid och svinn av material för kraftverksprojekt.

Datum: 24.5.2020 Sidantal: 21 Bilagor: 6

Abstrakt

Detta examensarbete är gjort för Wärtsilä Energy Business. Syftet med detta examensarbete är att reducera användingen av snabb flygfrakt för behövligt material vid kraftverket och för att idrifttagnings ingenjörer skall veta var materialet finns vid behov.

Jag har samlat information från experter vid Wärtsilä och underleverantörer genom möten och intervjuer. Data innehåller material som ofta går sönder på kraftverket och behövs genomgående.

Resultatet av examensarbetet innehåller fyra olika layouter av containrar samt ett excel-blad med behövligt material listat. Det har funnits ett behov att minska antalet användningar av snabb flygfrakt för kraftverks projekt och detta uppfyller det syftet.

Språk: Engelska Nyckelord: Kontainer, data, kostnadsminsking, frakt, logistik

---

Table of Contents

Figures

1 Introduction

This thesis is made on behalf of Wärtsilä Energy Business. The task was to see if a storage container on site with small material could be used to save time. There is a constant need for new ways to save time and cost for Wärtsilä projects. Small material is for example parts that tend to get lost on site or that are left unused due to wrong delivery. The aim of this thesis is to research if a new way of working can be found to reduce material being sent from Finland to power plants around the world.

1.1 Background

This study is made for Mechanical Engineering – Wärtsilä Energy Business. Wärtsilä Energy Business sells engine and external systems to customers. Wärtsilä is also in charge of making sure that engines are installed according to Wärtsilä instructions before the first start-up.

For every Wärtsilä project a list of commissioning spares is ordered to site. The list contains material that tends to break or fail while doing commissioning. These materials are shipped to site but often the site engineers are not sure where the material is when needed.
With a new way of working using 20- or 40-feet containers for these materials, some of these problems may be solved.

1.2 Problem Area

Wärtsilä projects are in need of making sure less material is needed to be sent after something breaks. This affects the way of working and it also increases costs for Wärtsilä. Each power plant is unique and what can be hard to estimate is which material the project engineers will have to send an excess of to the power plant site. When material is needed at the power plant site the process of shipping the material consists of the following steps:

The site engineer tells the project engineer of the project what material is needed, later on the project engineer asks quotation from the subcontractor. When the offer has been obtained a purchase requisition will be registered in Wärtsilä ERP system; SAP, so that the purchaser of the project can make a purchase order. Then the project appointed logistics coordinator is responsible of coordinating where the material is to be sent.

This process takes a lot of important manhours from many different departments at Wärtsilä.

1.3 Purpose

The main purpose of the thesis is to make sure commissioning engineers know where the material is when needed, by using a storage container at the power plant site, and to reduce material sent with fast air freight to the power plant site.

By conducting interviews with stakeholders at Wärtsilä, valuable information can be gathered and using that information, an excel sheet of material can be produced. I can gather valuable information and using that information to produce a excel sheet of material and four different layouts of containers, two 20 feet container layouts and two 40 feet container layouts. The list and layouts will then be available at Wärtsilä internal websites for project teams. The project team can then choose to include it in their project. This thesis will hopefully be used in future projects or be an eye-opener for future research.

1.4 Delimitation

The main focus for this thesis is to gather data from stakeholders and look into how to install the container. Furthermore, I will focus on gathering costs of the material by asking offers from subcontractors.

The thesis will investigate a small part of the logistical process of the project but will leave out some details due to the scope of this thesis.

1.5 Central terminology

In this chapter central terminology will be presented.

CPE – Chief Project Engineer

EEQ - Engineered Equipment Delivery

EPC - Engineering, Procurement and Construction

EPCM – Engineering, Procurement and Construction Management.

ERP - Enterprise Resource Planning

LNG – Liquid Natural Gas

PE – Project Engineer

SAP - Systems Applications and Products

1.6 Confidentiality

This version of the thesis can be studied by everyone. The internal version of the thesis covers a lot of sensitive data that cannot be shown outside of Wärtsilä. Therefore, some of the result chapter is classified and only people inside Wärtsilä can study it.

2 Wärtsilä

Founded in 1834, Wärtsilä first started as a small sawmill in Karelia and today it is a global leader in smart technologies. In energy and marine markets, they offer complete lifecycle solutions. Wärtsilä operates in more than 80 countries and employs approximately 19000 employees. (Wärtsilä, History, 2019)

Wärtsilä's purpose is to enable sustainable societies with smart technology. To fulfil its purpose Wärtsilä has established a strong presence in key growth markets and maintains that presence also by continuing to ensure that offering deliver best value to customer and transforming the company to a smart technology and redefining the brand. (Wärtsilä, Strategy & Purpose, 2019)

Energy Business

Wärtsilä Energy Business focuses on designing and building of power plants. The area of customers are industries, utilities and independent power producers. With a big and broad portfolio of solutions they offer energy storage systems, LNG-terminals, distribution systems, ultra-flexible internal combustion engine-based power plants and solar power plants. Energy business is transitioning towards 100% renewable energy.

Marine Business

Wärtsilä is world leading actor in marine technology, with innovative solutions and expertise. Wärtsilä delivers reliable, efficient, flexible and environmentally sustainable technology for its customers. Wärtsilä is moving towards a smart marine ecosystem.

2.1 Project Organization

Figure 1 shows how a project organization is set up in Wärtsilä. The project team includes a CPE:s for mechanical, electrical and civil engineering, and PE:s in the same fields. The project team also has a logistics coordinator who is responsible for the logistics of the project. The project controller is also included in the project team and he works closely together with the project manager.

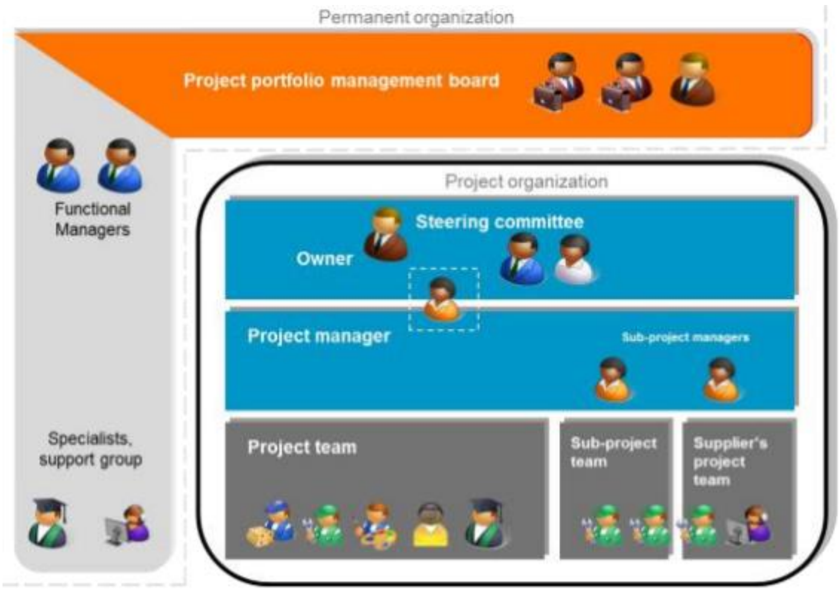


Figure 1; Project organization at Wärtsilä (Wärtsilä Internal Website, 2020)

2.2 EPC & EEQ Projects

Energy Business operates with two different types of projects, EPC & EEQ projects. Namely, Engineered Equipment delivery projects (EEQ) & Engineering, Procurement and Construction (EPC) projects.

Wärtsilä is responsible for EEQ projects that are limited to issues which are in the scope of supply for the installation equipment that they provide for the project. For EPC projects, Wärtsilä is responsible for the entire completion of the project, which includes designing, planning, logistics, construction, installation & commissioning.

Every project is different from another, so the commissioning list is not the same for every project. The difference between an EPC- or EEQ project is even greater. Different parts for different motors tend to break and the location of the site has a big influence on how the work is going at site. (Wärtsilä, Project service, 2020)

Figure 2 shows who is responsible for which scope.

PROJECT SERVICE SCOPES

PROJECT SERVICES		BASIC EEQ	EXTENDED EEQ	PROCESS EPC	EPC	EPCM
PROJECT MANAGEMENT	Delivery coordination	●	●			Fully customizable
	Construction management					
	EPC responsibility			●	●	
ENGINEERING	Basic engineering of main systems	●	●	●	●	
	Detailed plant engineering		●	●	●	
PROCUREMENT	Procurement of main equipment	●	●	●	●	
	Procurement of balance of plant equipment and material		●	●	●	
LOGISTICS	Logistics acc. to contractual delivery items	●	●			
	Logistics to site			●	●	
INSTALLATION & CONSTRUCTION	Site management advisory	○	○			
	Site logistics advisory	○	○			
	Project Scheduler/Planner service	○	○			
	Health, safety, environment (HSE) advisory	○	○			
	Technical advisory during installation	○	○			
	Construction management and site supervision			●	●	
	Subcontracting			●	●	
	Civil works (substructures)				●	
	Installation works			●	●	
COMMISSIONING	Commissioning advisory service	●	●			
	Commissioning			●	●	
	Commissioning management			●	●	

● = included service
○ = optional service

Figure 2; Project service scopes (Wärtsilä, Project service, 2020)

3 Theory

This chapter will present the theory for this thesis. The beginning of this chapter will present the term “commissioning” then focus on logistics and transportation theory. Theory related to container storage systems is also presented.

3.1 Commissioning

To achieve and validate that Wärtsilä systems are designed, installed and tested and therefore capable of being operated and maintained, quality controls are done during the different processes.

Commissioning service that Wärtsilä includes validates the functions and performance of installed equipment and the entire plants systems where safety and quality are focused on. (Wärtsilä, Project service, 2020)

According to (Killcross, 2012) Commissioning can be broken into three categories;

- Pre-commissioning includes installation of material, cleaning of material and equipment, punch listing and loop testing. This is the phase where they prepare the power plant to move into the next stage.

- Commissioning, in this phase the various systems are put into initial operation. The unit is leak tested as well. Start up and shutdown are also included in this phase.

- Start up, the phase when the plant is started up for actual operation

3.2 Logistics

The term logistics can be defined as a process consisting of phases and activities, by using efficient and effective transportation and storage of goods throughout the entire process and controlling the process is of high importance to ensure this. By using services as well as information from the start to the point of consumption, Wärtsilä can adapt to different customer requirements. Inbound, outbound, internal and external movements are terms that are included in this definition. (Visions, 2010)

From only referring to transportation and warehousing to now being a huge part of the strategy a company is using, logistics have grown the last decades. (Oskarsson;Aronsson;& Ekdahl, 2013)

Wärtsilä logistics service consists of a global network with reliable partners and professional transport management. Logwis is an information system that Wärtsilä is using for logistics information. (Wärtsilä, Project service, 2020)

Inventory

Companies have got a lot of reasons to keep inventory of products, the main reason is to provide a buffer between supply and demand. By purchasing a huge quantity of a product at a time you can get a discount, which means you get a lower price per product. It is also important to offer immediate service and provide spare parts for maintenance. (Rushton;Croucher;& Baker, 2017)

3.3 Maritime transport

According to (Rushton;Croucher;& Baker, 2017) 90 per cent of international trade are using sea freight. When shipping high-volume cargoes that have long lead times, using sea freight is perfect. This mode of transportation has the risk of delay. In sea freight common shipping terms are used for trade newcomers. (2Merkato, 2009) These are the most commonly used terms:

- Full container load (FCL) - goods will fill a container.
- Less than container load (LCL) – This means that a shipment will not fill a full container, and consequently will get consolidated with other LCLs to fill a container.
- Hook to Hook – When offering general goods for sea transport, shipping lines use this term. This includes loading costs on and off the vessel and transportation costs between origin port and the destination port.

3.4 Air transport

Advantages of transporting goods by air are that cargo, in a short period of time, may be carried long distances. Critical equipment that is required in a short time frame has the possibility to use air transport to avoid plant downtime. Disadvantages are the high costs, size and weight restrictions. There are also safety and security limitations to consider when using air freight. (Rushton;Croucher;& Baker, 2017)

Pricing

Space on an aircraft is limited due to payload restrictions, access door size and total volume of space, as well as the challenge that the shape of the aircraft presents. A large volume of air cargo is transported with passenger aircraft. Air cargo can be left off the aircraft due to other priorities, safety and passenger baggage are such priorities. Consequently, air freight is generally the most expensive type of transport, when comparing costs per tonne for the same journey by using different types of transport. In air freight costs are quoted as per kilogram where in other types of transport they refer to costs per tonne. (Lobel, 2018)

(Rushton;Croucher;& Baker, 2017) are referring to basic principles from which air freight pricing is calculated, these are:

1. Length x width x height = cargo volume. This must be accurately measured in centimetres.

2. The airline will charge air cargo depending on weight or volume. The calculation is done in the following way:

   $$1000 \text{ kg} = 6 \text{ m}^3$$

   or

   $$6{,}000 \text{ cm}^3 = 1 \text{ kg}$$

   Therefore

   $$1 \text{ m}^3 = 166.67 \text{ kg of chargeable rate}$$

3. By multiplying the agreed kilogramme tariff, you get the air freight rate. For example, a 150 cm x 100 cm x 45 cm box that weights 100kg calculates:

   Volume = 1.5 metres x 1 metres x 0.45 metres = 0.675 m^3

   The volumetric weight can then be calculated: 0.675 m^3 x 167 kg = 112.725 kg

4. When calculations are done, a simple process of checking the agreed tariff for this weight and destination is done. Freight forwarders or airlines can make agreements

of rate tariffs in advance. Cost per kilogramme decreases as the chargeable weight increases.

5. Fuel surcharge or warzone risk may also force the airlines to surcharges.
6. There will be additional charges apart from the air freight rate that only covers the cost from one airport to another. Some of these costs are:

    - Transport from vendors premises to the freight forwarders warehouse and transport to airport
    - Airport handling
    - Transport agency for delivering necessary documents
    - If required, security screening
    - Customs clearance

3.5 Time value

There are always ways to cover up problems such as production problems, unreliable vendors and problems with quality. Understanding how time and inventory are related you need to look at what adds and what does not add value to the supply chain. It is important to eliminate activities that do not give value, and instead, only add costs to the project. (Rushton;Croucher;& Baker, 2017)

3.6 Storage systems

Pallets are widely used in storage warehouses, but there are a lot of products that are not suitable for pallets. They can be too small, too long or too large. It can also depend on how they should be lifted. A survey that has been made about how goods are stored in warehouses has shown that pallets are used in 49.2% of the times, cases 18.6%, tote bins 14.4% and other 17.7% (Rushton;Croucher;& Baker, 2017)

Shelving

The most common way of storage for individual items is shelving. Solid metal shelves are typically 1,000 millimetres long and from 300 to 600 or more deep, they are built with one shelf on top of another with a total height of 2000 millimetres. The metal shelves can support a total of 200 kg by using steel frame and solid sides. Various specifications are available if needed for heavier material. For smaller individual items, a drawer unit can be used to store material. Shelving is normally located on the floor so it can be accessed easily. (Rushton;Croucher;& Baker, 2017)

3.7 Storage container

There are many different types of storage containers that can be used. In Figure 3(Smita, 2020) The specification for each of the dry storage containers is also shown.

	Container Type	Internal Dimensions	Door Opening	Cubic Capacity	Cargo Weight
	20FT General	L - 5.89M W - 2.35M H - 2.36M	W - 2.33M H - 2.26M	33 CBM	21700KG
	20FT High Cube	L - 5.89M W - 2.35M H - 2.69M	W - 2.33M H - 2.59M	37 CBM	21700KG
	40FT General	L - 12.05M W - 2.35M H - 2.36M	W - 2.33M H - 2.26M	66 CBM	26500KGS
	40FT High Cube	L - 12.05M W - 2.35M H - 2.69M	W - 2.33M H - 2.59M	76 CBM	26500KGS

Figure 3, Container types (Mainfreight, 2015)

Depending on manufacturer the dimensions can differ. Also, load regulations may restrict operation to less than maximum weight. **(Mainfreight, 2015)**

4 Method

In this chapter I will first present the method I have used to gather data for the thesis. The chapter will then shift over to the logistical process of the material and last focus on container sets.

4.1 My method of choice

I will use qualitative methods for this project, since it is the most suitable way to gather information and to see where the main problem lies. By using meetings and interviews with stakeholders and employees within Wärtsilä and subcontractors with good knowledge of this kind of project I will gather the needed information to this thesis. This way I was able to identify the most important problems with the existing way of working. I have not included every single conversation in this chapter, only the one I feel gave most input.

Before every interview a document with headlines was created that I brought up to discussion, so we could have a natural conversation about the topic. The topics were additional material for powerplant and their thoughts on the topic of the thesis. I also had follow-up meetings with two of the experts included. These expert’s names was given to me during a meeting with my thesis supervisor from Wärtsilä.

4.1.1 Interview with Mechanical Chief Project Engineers

CPE: s is responsible for the entire mechanical department of a project, work alongside other engineers and technicians. They are also involved in contract negotiating and approving designs. The CPE for a project is working closely together with the project engineer so all material is getting ordered in time.

The 3 CPE: s that I interviewed are experienced and have good knowledge of engineering, they have worked with many different projects across the world.

One issue they pointed out was that the amount of commissioning spares depends on what type of project you got and where the project is located. They could also identify the problems with the current way of working at the power plant sites.
The interviews concluded that a container with only screws, nuts and washers may not be ideal because these are not so difficult to get locally if missing.

One of the CPE: s also pointed out that tools could be held in this container, if rented engineers from Finland are sent to power plant site that need these tools. He also said that I should investigate if we could order everything from Würth. (Engineers C. P., 2020)

4.1.2 Interview with Mechanical Project Engineers

PE: s responsibilities are to study the scope of supply of the project and to contact subcontractors for offers. The PE: s are also responsible for delivering material that is needed as soon as possible to the power plant site.

These interviews were only done by email. I prepared a few questions for the 8 project engineers to think about. These questions focused on the material that is often sent as commissioning spares and extra material.

They provided commissioning spares lists and lists of extra material that has been ordered for projects. One PE also gave me some good questions to think about, including inventory and what will happen to the container after commissioning. (Engineers M. P., 2020)

4.1.3 Interview with Transport Manager

I also had an interview with an experienced Transport Manager to discuss the logistics of this project.

We discussed the process of getting the material from warehouses into the container at the powerplant. We came to the conclusion that sending an empty container for this is too expensive, it is better to use a container that has been emptied at the powerplant site. (Manager, 2019)

4.1.4 Interview with representantative from Würth

The representative from Würth has done much work for Wärtsilä in the past and has a lot of knowledge of what material that are being sent as extra material to powerplant sites. He is also experienced in installing a container and what material to use.

He provided a useful list of materials that are often ordered as spares for projects that were useful. I also got to see inside a 40 feet container that was useful for this study.

We discussed how to install and what material goes where in the container. Carrying capacity of the shelves was also on the topic, he explained the experience he had of different shelf materials. (Wurth, 2020)

4.2 Data

By gathering data from interviews with stakeholders I have produced a list of material in Microsoft Excel. A list of commissioning spares is available to order so site management can use it for commissioning. The data I received of the extra material was different, but some material was included from all experts. Extra material is often also ordered depending on the type of engine and fuel used. This data will be presented in the result chapter.

Shelves, tables, boxes and lockers are the materials I will use to furbish the container with. Intolog Vaasa has a big assortment of material that is used in warehouses across the world. The weight and the shape of the material differs a lot, so stable shelves with a lot of room are to be used. A worktable is used in every set of containers for its usefulness, as well as boxes to gather the material in that you need to bring from the container. There are also lockers with locks.

Additional material

Project engineers are ordering additional material for almost every different system. When installing the power plant, the additional material is to be placed in this container. So, if needed the engineers can obtain the material from the container.

4.3 Logistic process

The process from warehouse to site consists of a couple of steps. The material lists and container sets will be available on Wärtsilä internal website so they can be easily found by project engineers. If this container is included in the scope of supply the project engineers will enter it in SAP and the purchaser will send the subcontractor a purchase order. Furthermore, the logistic department will link the material that is appointed for the container with the materials that are ordered as commissioning spares and additional material.

When arriving at the powerplant site a subcontractor will install the empty container with material sent from Intolog Vaasa and when completed, place commissioning spares and additional material in the installed container.

4.4 Alternative option

An option to the way of working was also discussed where PE: s would gather data of lost, broken or wrong items that were sent to the power plant site and fill it in a excel sheet. Later on in the project, we will consolidate the material gathered and material from Intolog to a packing company, then ship it in a 20- or 40-feet container to the power plant site. This would make sure less parts are sent with fast air freight to the power plant site.

4.5 Inventory

For the subcontractor who is installing the container, a list of where to place the material is given and this is also included in the inventory book so when commissioning engineers need a material they can look where to find it.

The inventory of the material that is put in the container will be listed in a book where all the original packing lists are included. If the commissioning engineers need material from the container, they will have to write down material and quantity of the material. They will also have to write down the date when they have obtained the material.

Container access

This material is only used for commissioning and to ensure that a lock on the container door will be used so no one can access it without the key and use the material for something else than its purpose. The key will be held by commissioning manager.

If there is an urgent need for material when installing the powerplant and this material is found in this container, an arrangement can be made to use the material. This material must then be ordered for the container so it can be found when doing commissioning.

4.6 Container sets

I started off with making four different sketches of containers. Two for 20 feet general storage containers and two for 40 feet general storage containers. These layouts were then approved and drawn in AutoCad with accurate dimensions. In the result chapter I will present the sets.

At Wärtsilä internal website the layout of the container sets, commissioning spares and extra material will be found as well as the costs of each set and material.

4.7 Carrying capacity

The weight and the shape of the material differs a lot, so stable shelves are to be used. Most of the commissioning spares and extra material is sent in small cardboard boxes, therefore, no heavy-duty racks are needed.

Carrying capacity is 750 kg per 1015 mm shelf while lockers have a carrying capacity of 150kg/layer. (Pohjanmaan Hylly- ja Trukkitalo, 2018)

5 Result

In this chapter I will present the results of this study, and by using the findings from field study I will explain the achievement.

Shelves, tables, boxes and lockers are the material I will use to furbish the container with. Intolog Vaasa have a broad selection of material that is used in warehouses across the world.

A worktable is used in every set of containers for its usefulness, also boxes to gather the material in that you need to bring from the container. Specification of height, length and width for every material is stated in the layouts. Layouts will also get a specific Wärtsilä document ID.

20 Feet Set 1

This first set of 20 feet container contains of a workshop workbench, 3 heavy duty closet, 6 light duty rack sections and 5 boxes. The layout can be found in appendix 1.

20 feet Set 2

The second set of 20 feet container contains of a workshop workbench, 2 heavy duty closets, 6 light duty rack sections and 10 boxes. The layout can be found in appendix 2.

40 feet Set 1

The first set of 40 feet container contains two workshop workbenches, 5 heavy duty closets and 12 light duty rack sections and 10 boxes. The layout can be found in appendix 3.

40 feet Set 2

The second set of 40 feet container contains of a workshop workbench, 6 heavy duty closets and 12 light duty rack sections and 12 boxes. The layout can be found in appendix 4.

Excel sheet of material.

The excel sheet I have produced consists of 4 columns: Item, Part number, Part name, and Quantity. The Part numbers are not available in this version due to confidentiality. The excel sheet also consists of sheets where the material for furbishing the container is listed, one sheet for each container set. In appendixes 5 and 6 examples of the excel sheet are shown.

6 Conclusion

In this chapter I will discuss if the goal of this thesis was met and I will also discuss the challenges and how this project can be further developed.

6.1 Was the purpose reached?

The purpose of this thesis was to make sure engineers at power plant sites know where extra material is to be found when doing commissioning and to reduce the usage of fast air freight for material. The result I have gathered in this thesis fulfils that purpose. However, improvements are to be made to this as well as the usage of fast air freight will not completely stop as every power plant are different and the same material does not break at every power plant.

6.2 Challenges

While gathering information I stumbled upon a lot of different challenges, these challenges have been an eye opener for myself. One challenge was to get answers from the stakeholders and know what questions to ask for the best answer. I feel like I could have gathered more data from different stakeholders at Wärtsilä.

Another challenge was to get backup and focus when failing at a meeting, I had one meeting were I felt like I could have gotten much important information, but I did not ask the right questions.

The last challenge was to draw the layouts in Autocad, I have little to no experience in using AutoCad. After a couple of hours drawing lines and changing dimensions, I feel like I have started to feel comfortable using Autocad.

6.3 Further research

An idea that came up while having meetings with my supervisor was to use a container for a workshop, there we can see how well this is used and what improvements are to be made. Another improvement is to mark what shelves are for what material in another way so that the engineers easily find the material in the container.

An idea to further look into, mentioned earlier in Chapter 4.4, is to consolidate needed material to a packing company, then pack it in a container with shelves and lockers and ship it to the power plant site are also an idea to look into further.

7 References

2Merkato. (den 08 03 2009). *Shipping Terms*. Hämtat från 2Merkato: https://www.2merkato.com/articles/shipping/shipping-info/60-shipping-terms

Engineers, C. P. (2020). Interview with Chief Project Engineers. (A. Norrgård, Intervjuare)

Engineers, M. P. (2020). Interview with Mechanical Project Engineers. (A. Norrgård, Intervjuare)

Killcross, M. (2012). What is Commissioning? i M. Killcross, *Chemical and process plant commissioning handbook : a practical guide to plant system and equipment installation and commissioningVisa detaljrik vy* (s. 13). London: Butterworth-Heinemann/Elsevier.

Lobel, B. (den 15 08 2018). *Air freight guide: Process, costs, and timelines*. Hämtat från Small business.co.uk: https://smallbusiness.co.uk/the-essential-guide-to-air-freight-process-costs-and-timelines-2544053/

Mainfreight. (den 14 May 2015). *Mainfreight*. Hämtat från Freight Basics - Shipping Container Specifications: https://www.mainfreight.com/global/en/basics/freight-basics-shipping-container-specifications.aspx

Manager, T. (2019). Interview with Transport Manager. (A. Norrgård, Intervjuare)

Oskarsson, B., Aronsson, H., & Ekdahl, B. (2013). *Modern logistik : För ökad lönsamhet.* Stockholm: Liber .

Pohjanmaan Hylly- ja Trukkitalo. (2018). *Intolog-kuvasto.* Vaasa: Pohjanmaan Hylly- ja Trukkitalo Oy.

Rushton, A., Croucher, P., & Baker, P. (2017). *The Handbook of Logistics and Distribution Management.* London: Kogan Page.

Smita. (den 15 April 2020). *16 Types of Container Units and Designs for Shipping Cargo*. Hämtat från Marine Insight: https://www.marineinsight.com/know-more/16-types-of-container-units-and-designs-for-shipping-cargo/

Visions, S. C. (2010). *SUPPLY CHAIN and LOGISTICS.* Hämtat från SUPPLY CHAIN and LOGISTICS: http://www.iwla.com/assets/1/24/2010_Glossary_of_Terms_10.7.11.pdf

Wärtsilä. (2019). *History*. Hämtat från https://www.wartsila.com/about/history

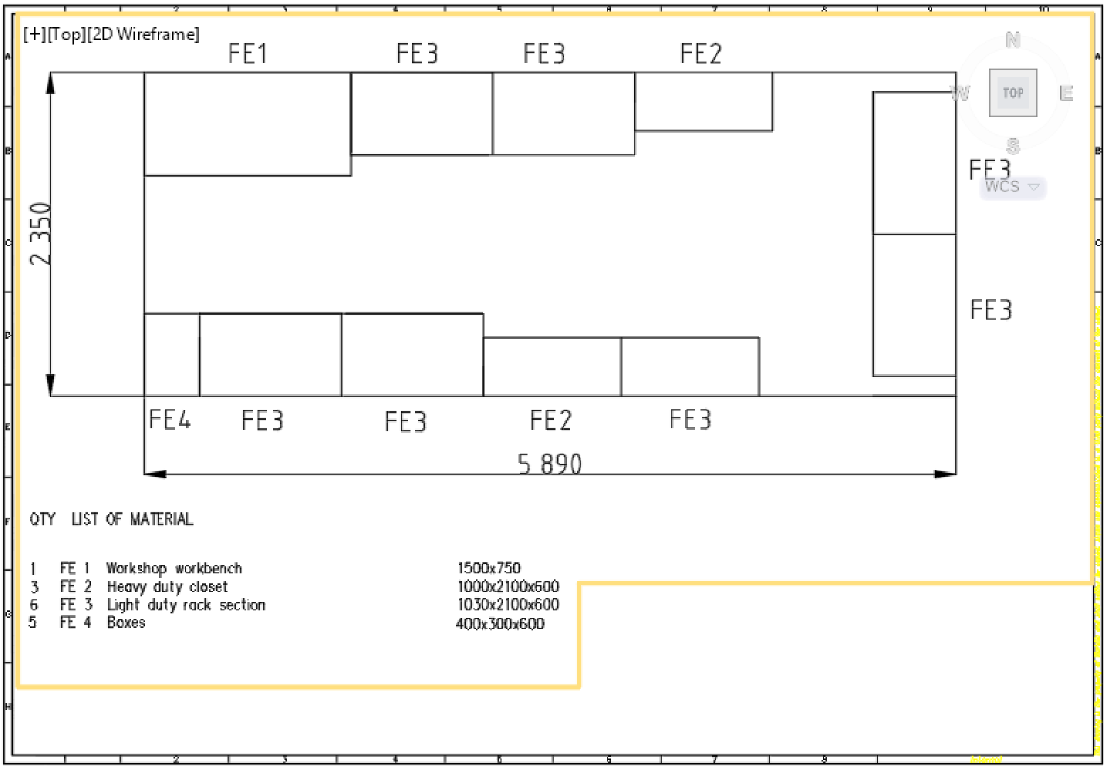
Wärtsilä. (2019). *Strategy & Purpose*. Hämtat från https://www.wartsila.com/about/strategy

Wärtsilä. (den 17 April 2020). *Project service*. Hämtat från Wärtsilä project service: https://www.wartsila.com/energy/explore-solutions/Project-management-financing

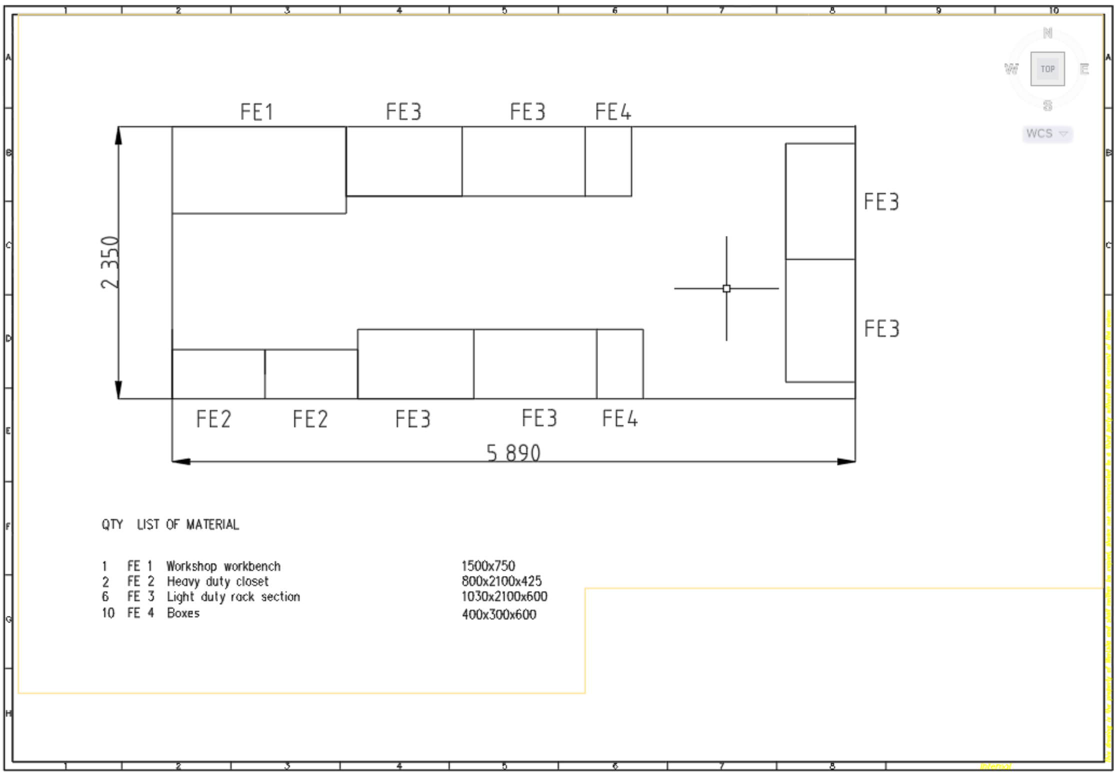
Wärtsilä Internal Website. (den 24 05 2020). *Wärtsilä Internal Website*. Hämtat från Wärtsilä Internal Website.

Wurth, R. f. (March 2020). Interview with representant from Wurth. (A. Norrgård, Intervjuare)

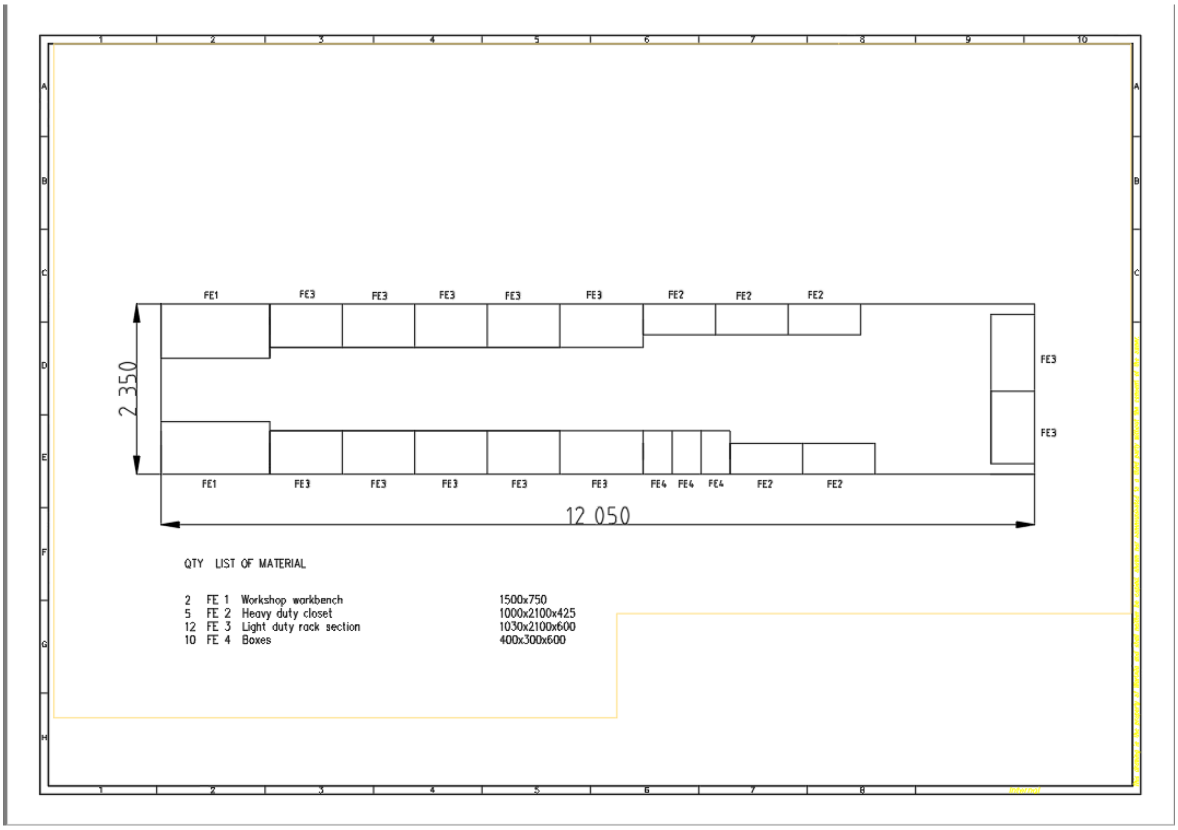
Appendix 1 20 Feet Container Set 1



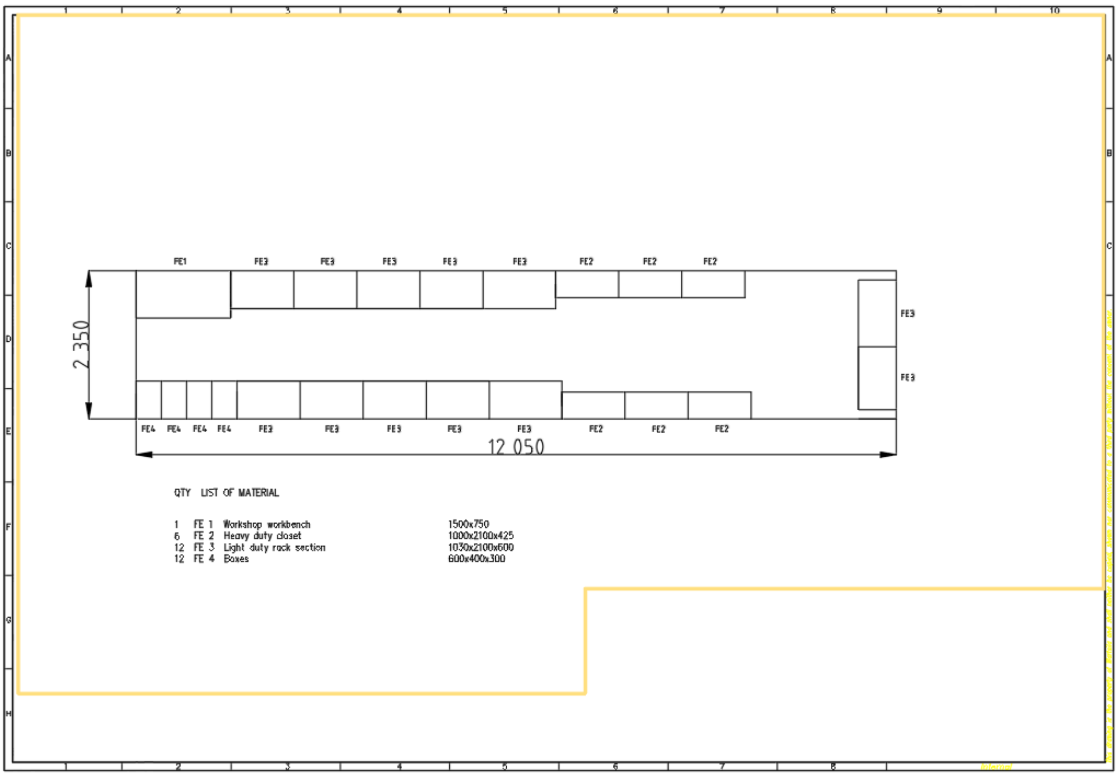
Appendix 2 20 Feet Container Set 2



Appendix 3 40 Feet Container Set 1



Appendix 4 40 Feet Container Set 2



Appendix 5 Excel Sheet (1/2)

Item	Part number	Part name	Quantity
Main commissioning spares			
		O-ring	4
		Main bearing kit	1
		Cylinder liner sealing kit	1
		Piston ring kit	1
		Big end bearing kit	1
		Cylinder head replacement kit	2
		Prechamber, complete	2
		Sealing kit for prechamber	2
		Main gas admission valve	2
		Sealing kit for gas manifold	2
		Sealing kit for automatic filter	1
		Filter kit for automatic filter	1
		Sealing kit for centrifugal filter	1
		Paper insert kit	1
		Spark plug	20
		Ignition coil assembly	2
		Cylinder control module	1

Appendix 6 Excel Sheet (2/2)

A	B	C	D	E	F	G	H	I	J	K	L
Item	Item ID	Qty	Costs:								
Lighty Duty Rack Section	006549	6									
Boxes	79378200050	10									
Workshop Workbench	TP712	1									
Heavy Duty Locker	C 309 07 001	3									

Commissioning spares & Material | **20 feet set 1** | 20 feet set 2 | 40 feet set 1 | 40 feet set 2

:räkningsläge : Automatiskt Arbetsboksstatistik